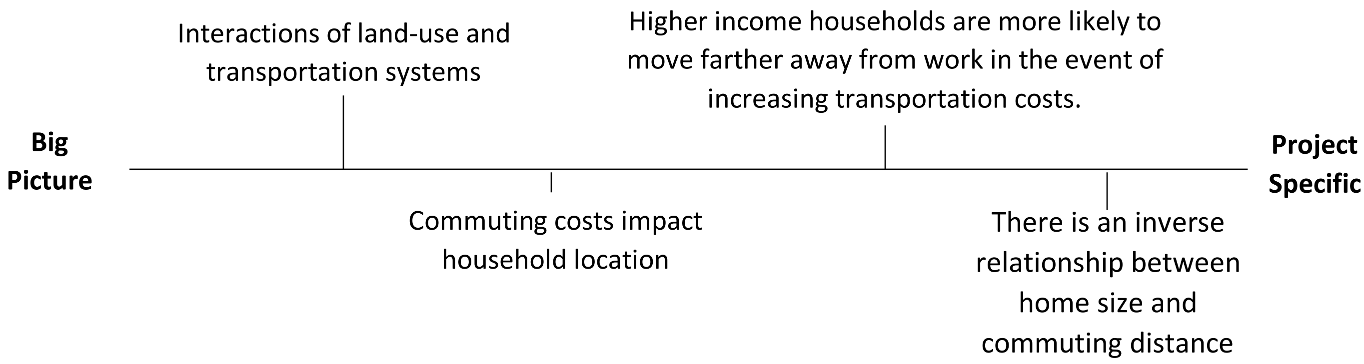
Lesson 5: Outlining Your Thesis Rationale

Thesis rationale example 1:



Claim	Higher commuting modal accessibility leads to a reduction in total commuting distances of two-commuter households
Justification	This is likely since households residing in areas that yield higher accessibility do not need to be located far away from their workplaces.
Evidence	The direct utility model for *household commuting distance* considers several variables. The results indicate that *household commuting distance* is inversely affected by the expected maximum utilities of the commuting mode choices (-0.16 with a t-stat of -5.27).

Claim	Urban areas that include a high number of two-worker households with workers generally travelling in the same direction may be an indication that there is a lack of job centers near these households.
Justification	The travel demanded for the trip to work is dictated by home and work locations. Same directions trips from home locations indicate numerous trips to work.
Evidence	Econometric modelling structure to explore the relationship between commuting modal accessibility and the home-work spatial configuration of two-worker households. The measured variable is the angle (the angle between the two work locations measured from their common home location). Acute angles are representative of workers travelling in the same direction. The results show an inverse relationship between *household commute distance* and *angle* (parameters -0.2 with t-stat of -0.54).

Claim	Higher income households are less likely to relocate closer to work and more likely to move farther away from work in the event of increasing transportation costs.
Justification	Higher income households are more interested in maximizing utility gained from living in larger spaces of land and these are less impacted by commuting costs
Evidence	Discrete choice model to examine household choices under scenarios of rising commuting costs in the Greater Toronto Area. The model considers a combined

	choice of home relocation and mobility tool ownership changes. The model variable "household income" is estimated with a negative coefficient for the choice "Move Closer to Workplace Location" and positive coefficient for the choice "Move Farther Away from Workplace Location".

Claim	There is an inverse relationship between home size and commuting distance.
Justification	Households with larger homes dedicate a larger proportion of their household budget to home costs and therefore are sensitive to increases to commuting. These household are likely to relocate in order to reduce their commuting distance and subsequently lowering household commuting costs.
Evidence	Cobb-Douglas and multi-level random intercept models of commuting distance suggest that the variable size of current home (i.e., the total floor area of the respondents' current homes) has an estimated negative coefficient.

Derived from: Akbari, S. (2018). Land-use and Transportation Interactions through the Lenses of Two-Worker Households, Rising Commuting Costs and Transit-Oriented Development (Doctoral dissertation)

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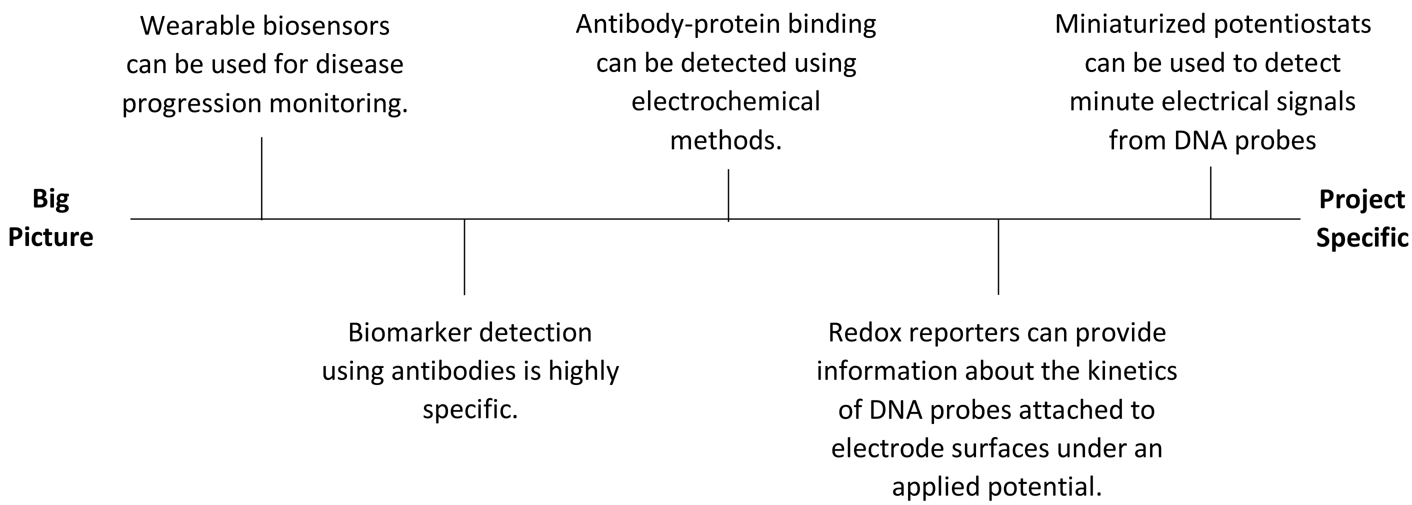
Thesis rationale example 2:



Claim	Wearable biosensors can be used for disease progression monitoring.
Justification	Commercial wearables have built-in technology to do physiological monitoring through heart-beat monitoring, oxygen levels, etc., which all serve as biomarkers in the user. Translating this to disease biomarkers found in bodily fluids is the next step for the technology.
Evidence	Current works describing detection of glucose, antibodies, among others, are being researched with many already existing for the public (e.g. glucose sensors). Kim, J et al. Wearable biosensors for healthcare monitoring. Nature Biotech (2019).

Claim	Biomarker detection using antibodies is highly specific.
Justification	Monoclonal antibodies are highly specific to targets (biomarkers) of interest, including proteins which are upregulated in disease progression.
Evidence	Antibodies are widely used in immunosensors to detect proteins with high specificity and repeatability – the advent of monoclonal antibodies with hybridoma technology ensured repeatable production. Borrebaeck, C. Antibodies in diagnostics – from immunoassays to protein chips. Immunology Today (2000).

Claim	Antibody-protein binding can be detected using electrochemical methods.
Justification	Antibody-protein binding creates a new complex, so with the addition of electrochemical species in an assay, changes can be monitored due to steric

	effects, electron transfer characteristic changes, and diffusional changes in solution.
Evidence	Immunosensors rely on conformational changes to detect the presence and absence of targets, with many works reporting the use of electrochemical reporter molecules to present these changes as current measurements.

Claim	Redox reporters can provide information about the kinetics of DNA probes attached to electrode surfaces under an applied potential. Das, J and Gomis, S et al. Reagentless Biomolecular Analysis Using a Nanoscale Molecular Pendulum. BioRxiv (2020).
Justification	By conjugating redox reporter molecules to DNA probes, conformational changes at the distal points of the DNA probes (i.e. attachment or detachment of target proteins) can be measured by the change in electron transfer efficiency of the redox reporter to the electrode surface.
Evidence	Substantial works use redox reporters conjugated to DNA to measure conformational changes, such as by having DNA hairpins open up and causing the redox reporters to move further away from the electrode, or aptamer binding causing redox reporters to move closer to the electrode. Campuzano, S. Reagentless and reusable electrochemical affinity biosensors for near real-time and/or continuous operation - Advances and prospects. Current Opinion in Electrochemistry (2019).

Claim	Miniaturized potentiostats can be used to detect minute electrical signals from DNA probes
Justification	Potentiostats are hardware configurations which can allow for electrochemical measurement detection through various applications of potential sweeps and steps to electrode configurations. Through appropriate design, miniaturization of potentiostats will allow for them to be more portable, small enough to be in a wearable device, such that an electrochemical electrode system can be fixed on a user's body (e.g. on skin, on a tooth, or in any other *in situ* deployment to allow for continuous monitoring).
Evidence	Companies such as Texas Instruments and Analog Devices are producing potentiostats in integrated circuit formats for wearable designs, and collaborations with electrochemical detection manufacturers such as PalmSens are contributing to wearable solutions being possible. These devices have been used in comparison to existing lab-bench potentiostats to demonstrate their sensitivity to protein detection using DNA probes. Bariya, M et al. Wearable sweat sensors. Nature electronics (2018).

Lesson 5: Outlining Your Thesis Rationale

Thesis rationale example 3:

Automated external defibrillation (AED)
Out-of-hospital cardiac arrest (OHCA)

Big Picture

Survival following OHCA, a common and fatal emergency event, can be dramatically increased from interventions focused on rapid treatment.

Effective OHCA interventions can be delivered by untrained bystanders or non-medically trained individuals.

Bystander response and AED use in out-of-hospital settings can reduce the delay in treatment and improve OHCA outcomes.

The location and placement of AEDs in public places for bystander use is a critical factor to ensure successful AED based bystander response interventions in practice.

Bystander AED use in practice is low due to existing public access AED placements driven by uncoordinated local initiatives as well as sub-optimal recommendations for placement by international health organizations

Project Specific

Claim	Survival following out-of-hospital cardiac arrest (OHCA), a common and fatal emergency event, can be dramatically increased from interventions focused on rapid treatment.
Justification	Cardiac arrest, an electronic malfunction of the heart that causes a loss of functionality, is a leading cause of death in North America alone, indication its high incidence and low survival outcomes. Cardiac arrest survival decreases rapidly for every minute without treatment due to the lack of blood flow and thus oxygen to the body. This is detrimental for OHCA where treatment cannot be immediately be provided by nearby physicians. Thus, interventions that provide rapid treatment, which aim to restore the heart function/delivery of oxygen to the body, in the out-of-hospital setting can and has been shown to improve survival outcomes.
Evidence	Over 700,000 OHCA related deaths occur annual in North American and Europe, corresponding with an overall survival rate of less than 8%. OHCA Survival decreases by approximately 7-17% for every minute without treatment (i.e., defibrillation).

Claim	Effective OHCA interventions can be delivered by untrained bystanders or non-medically trained individuals.
Justification	Cardiopulmonary resuscitation and defibrillation are both live saving interventions that can be delivered safely and effectively with little to no prior training by regular bystanders. Defibrillation, specifically, can be delivered using an automated external defibrillator (AED), a medical device that is applied on the victim to detect an abnormal heart rhythm and subsequently deliver an electrical shock to restart the heart and resuscitate them. These devices include instructional diagrams and voice commands to ensure ease of and proper use.
Evidence	It has been found that AEDs can be set up and used by sixth-grade students nearly as quickly as trained paramedics, demonstrating an AED's ease of use.

Claim	Bystander response and AED use in out-of-hospital settings can reduce the delay in treatment and improve OHCA outcomes.
Justification	Given bystanders are able to deliver OHCA interventions, there is an opportunity for treatment to be delivered before traditional EMS services arrive. In fact, treatment time has been reduced through telephone assisted CPR delivery, where a bystander that has called 911 is coached by the EMS dispatcher to provide CPR to the victim. Similarly, a nearby AED, if accessible, can be retrieved and used on the victim also rapidly reducing the delay of treatment
Evidence	Clinical trials, such as the Public Access Defibrillation (PAD) trial, have shown that survival rapid AED use can triple the chance of survival, relative to no AED use, following an OHCA. Bystander OHCA recognition, CPR, delivery and rapid defibrillation have been identified as key factors of survival in the OHCA "Chain of Survival", a concept endorsed by the American Heart Association and similar health organizations across the world.

Claim	The location and placement of AEDs in public places for bystander use is a critical factor to ensure successful AED based bystander response interventions in practice.
Justification	At a fundamental level, AEDs must nearby OHCA victims as well as accessible to a bystander for them to be retrieved and used in a timely manner. Strategically locating AEDs in areas of high risk OHCA risk or locations of interests (e.g. primary schools), ensuring they are accessible during any time of day, and where bystanders are likely to act are essential for public access defibrillation programs to succeed.
Evidence	International guidelines recommend AED placements in high-traffic public locations where OHCAs are likely to be witnessed to facilitate AED use. Data-driven strategies entail placement in locations with a high historical OHCA incidence. Location and accessibility are critical considerations during placement – roughly 1 in 5 OHCAs occurred nearby an inaccessible AED, during the time of arrest (i.e. an AED could potentially been have used, if it were accessible to the public).

Claim	Bystander AED use in practice is low due to existing public access AED placements driven by uncoordinated local initiatives as well as sub-optimal recommendations for placement by international health organizations
Justification	Local initiatives commonly place AEDs in locations that do not align with OHCA risk or in locations with poor temporal accessibility such that bystanders cannot access them all times of day. Guideline recommendations from international health organizations also overlook temporal accessibility of AEDs and often do not provide guidance beyond obviously high-risk locations (e.g. airports, casinos, etc.), causing such guidelines to be difficult to follow and implement.
Evidence	Bystander AED use and survival rates for OHCA victims are low, approximately 20% and 15% respectively, despite the tremendous amount of resources dedicated to AED placement.